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A Field Medical Surveillance System for Deployed Forces: A Conceptual Model

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An important function of any military medical service during combat operations is the prevention of infectious and parasitic diseases. Military personnel may be deployed in developing countries where various infectious and parasitic diseases are endemic, and the potential for widespread illness in US troops is a threat to combat readiness. Timely recognition of such illnesses requires systems to detect these diseases early so they can be quickly investigated and controlled before they become a major health crisis. Prompt detection requires careful monitoring and a thorough understanding of the trends in incidence and distribution of known endemic agents. Surveillance with appropriate laboratory support is critical to an effective defense against these potential illnesses. This paper describes a conceptual model for a Field Medical Surveillance System (FMSS) designed to assist military Environmental Health Officers (EHOs), and Preventive Medical Officers (PMOs) in the prompt detection and prevention of illnesses that may occur during foreign deployments or conflicts.

INTRODUCTION

The health of US service personnel deployed to foreign countries is vitally important to the successful completion of the intended mission. Upon relocation, these personnel represent non-indigenous populations exposed to the endemic diseases and other hazards associated with their assignment. Within these groups, outbreaks of infectious and parasitic diseases can render many individuals unable to perform their duties, place a severe strain on medical resources, jeopardize their missions, and possibly endanger the lives of those stricken.

Historically, infectious diseases have had a significant impact on military operations. In World War II, 55,668,000 man-days were lost from duty as a result of infectious diseases.¹ During the recent Operation Desert Shield/Storm (ODS/S) deployment to the Middle East, large outbreaks of diarrheal illness occurred in US troops. Incidence rates exceeding 10% of the force strength each week were reported in some units, and it was estimated that during the first month of the operation, at least 50% of all troops were affected.² One of the largest outbreaks was the occurrence of food-borne gastroenteritis in Jeddah, Saudi Arabia, during ODS/S, which affected 648 Air Force flight line personnel.³ Other endemic diseases of military significance that posed a potential threat during ODS/S included hepatitis, leishmaniasis, sandfly fever, Crimean-Congo hemorrhagic fever, schistosomiasis, and malaria.⁴

One of the primary tasks for preventive medicine personnel at Echelon II is to conduct and coordinate medical surveillance for selected diseases of military operational importance.⁵ During 1992 US troops who were deployed to Somalia to take part in Operation Restore Hope were exposed to a number of endemic diseases of that region, including dengue fever, malaria, and diarrheal diseases caused predominantly by enterotoxigenic *E. coli* and various species of *Shigella*.⁶ To minimize the impact of these diseases, commanders strongly emphasized preventive measures. An infectious disease control team was deployed, and a medical surveillance system was put into effect. This system required all new outpatient visits to be recorded and classified into one of 14 diagnostic categories, such as gastrointestinal, acute respiratory infections, and unexplained fever. Once a week, or when conditions permitted, an epidemiologist visited each clinic and recorded the number of new outpatient visits for each of the fourteen diagnostic categories. These data were tabulated, and incidence rates based upon known troop strength then were calculated. An increase in incidence of any diagnostic category indicated a situation that needed further investigation.⁷ Although this system helped pinpoint potential problems, it was time consuming and labor intensive. These aggressive efforts, however, helped to reduce the morbidity caused by these illnesses and emphasized the importance of having preventive measures in place.

To minimize the impact of disease on deployed forces, EHOs and PMOs need timely information with which to make *information-driven decisions*, better ways to communicate this information, and improved tools for analyzing and presenting the data. For infectious disease, the early warning provided by surveillance systems allows field commanders time to start various control activities. These activities may include isolating infective cases, immunizations, spraying pesticides, chlorinating wells, restricting food-handlers, and eliminating sources of open water.

The purpose of this paper is to present a conceptual model of a Field Medical Surveillance System (FMSS) that will allow for the timely recognition of adverse health events. The system will allow incidence and prevalence trends to be displayed and projected over the near term, and profiles of patient populations to be generated. By allowing prompt action to bring available resources to bear on emerging problems, an effective surveillance system in conjunction with appropriate laboratory support is a powerful tool in the defense against infectious diseases.

PREVENTIVE MEDICINE FUNCTIONS

For deployed units the epidemiological surveillance system should not require any additional labor beyond that needed to care for sick and injured personnel; therefore, to the degree possible, the system should use the data gathered primarily for clinical care. Analysis of clinical data would allow the following capabilities to be developed for EHOs and PMOs operating in the field:

1. **Detection of Illnesses Shortly After Their Onset** - Early detection would allow field medical personnel to quickly respond with appropriate control measures.
2. **Ability to Determine Both the Incidence and Prevalence Rates** - Determination of the incidence rate of a given illness would allow trends to be observed and comparisons made among different treatment facilities, while the determination of prevalence rates would allow bed usage and noneffectiveness days to be estimated.
3. **Projection of Short-Term Trends** - Estimating short-term trends would allow the adequacy of available resources and current disease control activities to be assessed.
4. **Ability to Profile the Characteristics of the Affected Population by Person, Time, and Place** - Having the ability to profile the affected population by various descriptive variables could be used to establish the major risk factors for a particular illness.
5. **Ability to Determine Mode of Disease Transmission** - Knowledge of the mode of disease transmission would allow preventive measures to be more focused.
6. **Compilation and Dissemination of Reports** - Results for the FMSS would be available on a timely basis to those individuals who are responsible for instituting preventive measures.
7. **Ability to Retrieve Medical Reference Materials** - Providing rapid access to current medical information that pertains to any of the diseases in the knowledgebase would ensure that the most current methods of control and prevention would be implemented.

DEVELOPMENT STRATEGIES

Two strategies were evaluated in the conceptual design for developing FMSS. The first strategy was to build a new system *de novo*, including building a knowledge base of endemic diseases considered to be of military importance. This knowledge base would consist of a "disease threat library" for each country, and it would include the clinical symptomatology, epidemiology, and therapy for each known disease from that country. This information can be obtained from the Armed Forces Medical Intelligence Center (AFMIC), which also publishes the Disease and Environmental Alert Reports (DEAR). These reports provide information on approximately 100 infectious and parasitic diseases considered to be of military importance.⁸ This information is available to military medical planners and covers every major country in the world, and it is used extensively during predeployment briefs. The second strategy was to design a "front-end" system that would use an available infectious disease knowledge base, but would allow for additional modules to be developed. One candidate infectious disease knowledge base is the Global Infectious Disease and Epidemiology Network, or GIDEON.⁹ GIDEON's knowledge base currently consists of 306 diseases (see Appendix), 205 countries, 556 bacterial taxa, and 137 antibacterial (fungal, parasitic, and viral) agents. This knowledge base uses literature published throughout the world, and it currently has more than 10,000 notes that outline the status of specific infections within each of the 205 countries. In addition, users around the world constantly add to the information pool, a critical and essential requirement given the rapidly changing status of newly emerging and drug-resistant infectious diseases.¹⁰

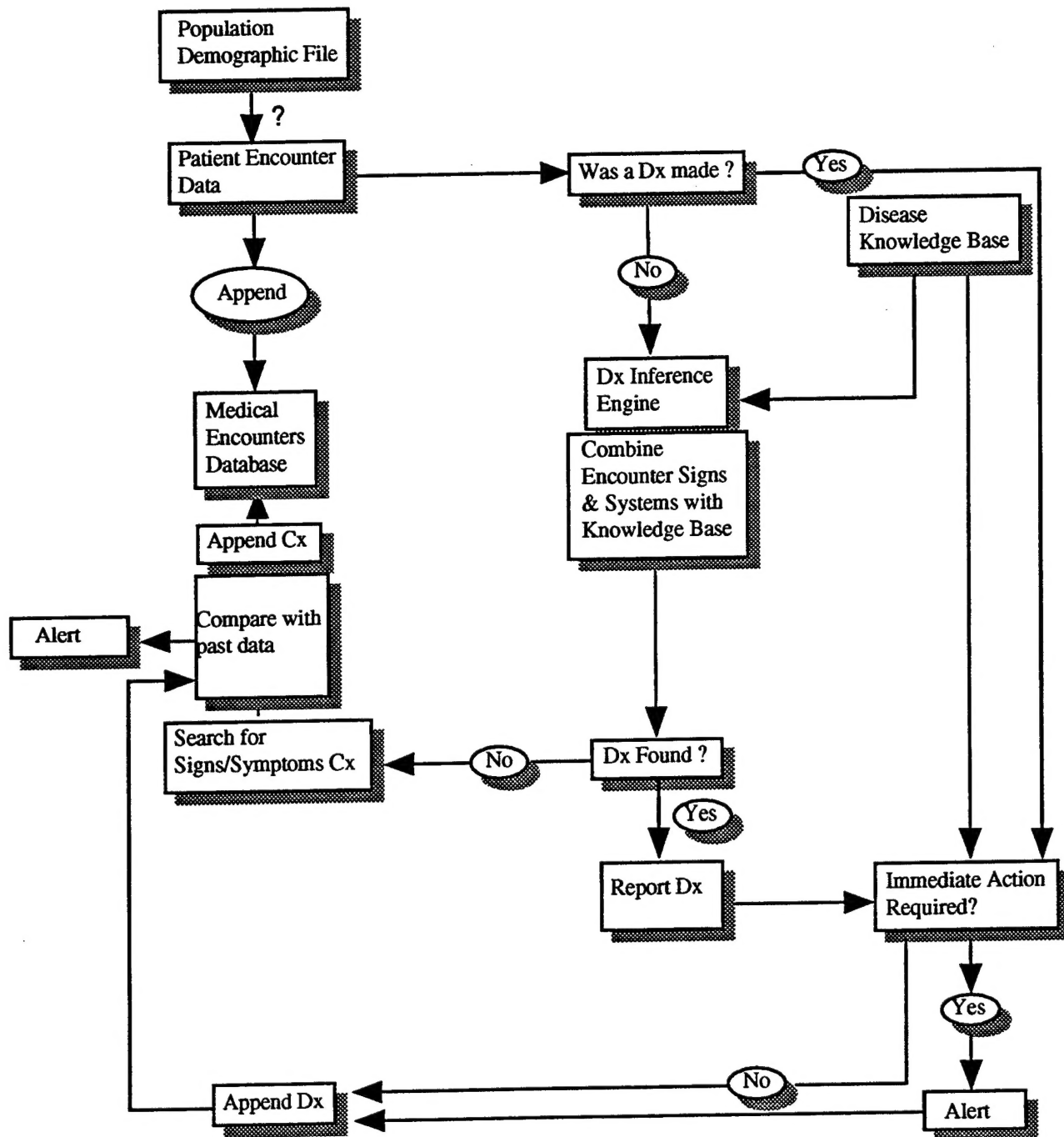
After consulting with Navy, Army, and Marine Corps specialists in the field of infectious diseases, it was determined that the most efficient use of time and resources would be to take the second approach and design a "front-end" system using the GIDEON's knowledge base. The crucial advantage here is that such a system will incorporate a knowledge base well known in the medical community. It is the product of more than 13 years of intensive collaboration between specialists in infectious diseases, epidemiology, microbiology, biostatistics, and computer sciences.^{9,11} Although an interface specific to military requirements will need to be designed and implemented, it was concluded this approach was more desirable than trying to duplicate the enormous amount of effort that has already been achieved with the GIDEON knowledge base.

Overall the system will consist of an initialization sequence, patient encounter processing, daily compilation of encounter data, and periodic updating of the knowledge base. A screen that allows the user to initialize the system will be available during start-up. This screen will allow

descriptive information to be added and will consist of data fields to capture troop strength, battle field location using Global Positioning System, and name of Medical Treatment Facility (MTF). To track each acquired illness to a particular MTF, a unique four-digit identifier will be assigned to each MTF during the initialization process. In addition, the user will be able to update this information at any time. The first process shown in Figure 1 is initiated when a patient seeks medical attention. At this point an attempt is made to assign a diagnosis based upon his or her presenting signs and symptoms. The health care provider may make a diagnosis, or a diagnostic computer algorithm may be used to generate a differential diagnosis using a knowledge base of known endemic diseases for that particular region of the world. Frequently however, a diagnosis cannot be made, so the patient's condition is documented in terms of signs and symptoms. Consequently, the capability to find patterns or clusters of signs and symptoms is being developed. Two promising Adaptive Resonance Theory algorithms have been developed and tested on simulated data.¹² When a pattern or cluster is detected by the system, the results are returned to the health care provider for review, and for suspected conditions that require immediate action, an alert dialogue box is displayed. If a diagnosis cannot be made or a cluster cannot be identified, then the patient will be assigned to one of fourteen general diagnostic categories.

The second process is a daily compilation of encounter data and is shown in Figure 2. The compilation of this report will be initiated automatically each day. The patient visit data will be reviewed and counts or incidence rates will be computed for each diagnosis or major diagnostic category. From these data and information on etiology, disease prevalence will be estimated as well as the near term incidence. In addition, those cases in which a clear diagnosis is determined, the potential mode(s) of transmission will be known (eg, air, water, food, insects, rodents). From these data, totals will be calculated for each disease vector and reported each day. Knowledge of the exposure route responsible for causing the majority of illnesses allows medical resources to be directed toward that particular route of exposure. Finally, actual incidence rates will be given along with the previous forecasts so any increases or decreases can be monitored. Comparing the actual rates with expected rates provides a measure of the effectiveness of ongoing preventive medicine efforts.

Patient Encounter Processing



Dx = Diagnosis
Cx = Cluster

Figure 1. Overall structure of Patient Encounter Processing.

Daily Report Processing

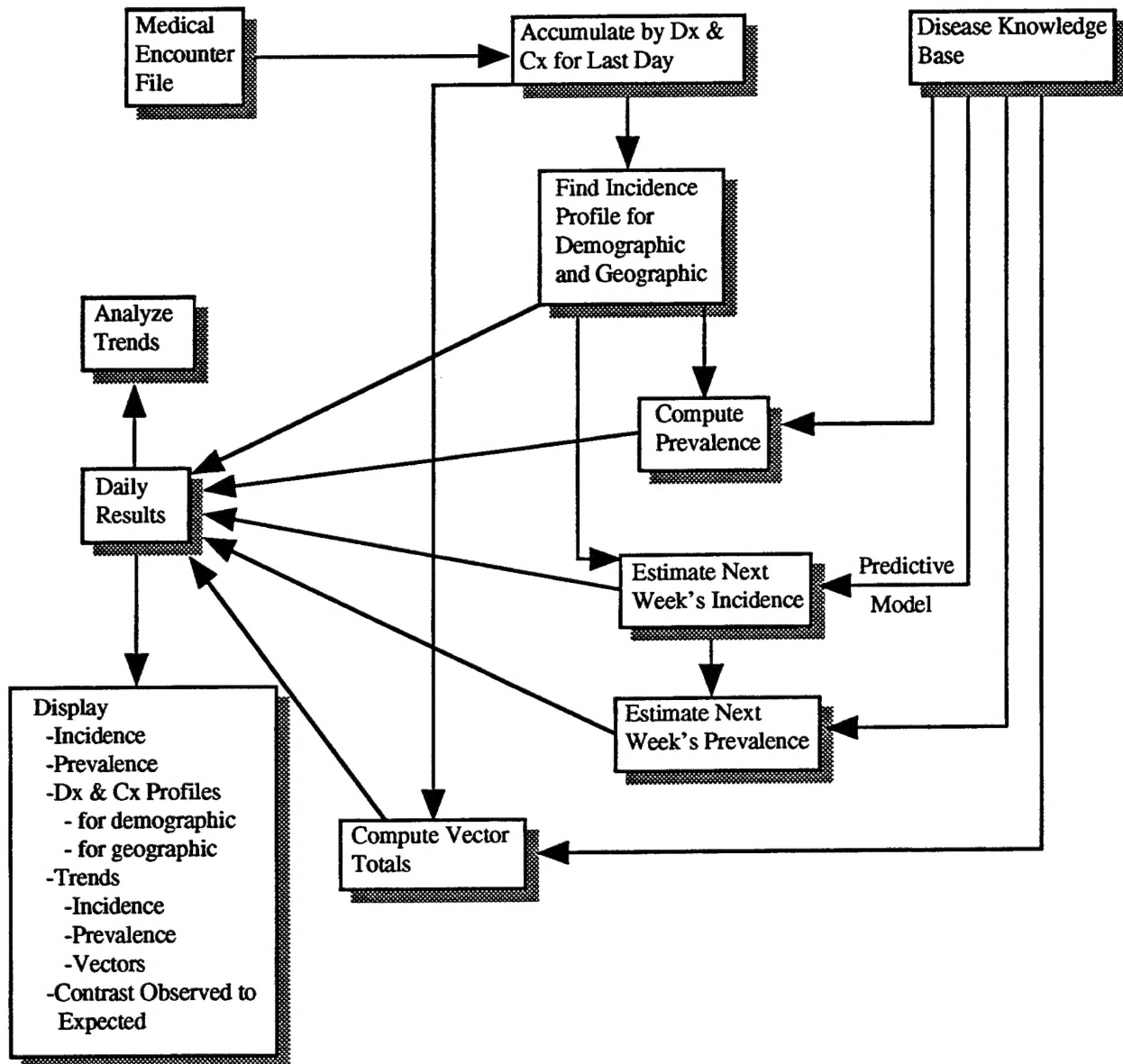


Figure 2. Overall structure of Daily Report Processing.

Knowledge Base Processing

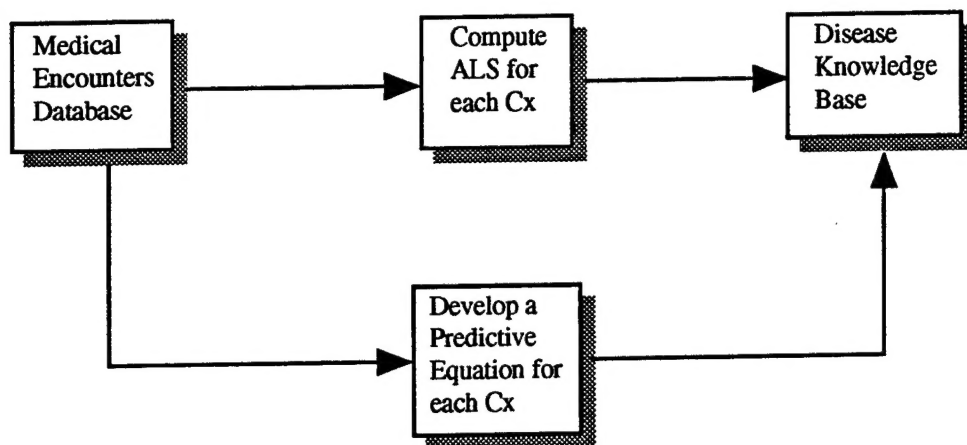


Figure 3. Overall structure of Knowledge Base Updates and Ad Hoc Reports.

The third process involves updating the disease knowledge base as shown in Figure 3. This process is simply a mechanism to use information acquired from the current military operation to help estimate average length of stay. Specifically, a series of patients may be seen for the same symptom complex but have no definitive diagnosis. This information, however, may be used to help determine bed requirements and the efficacy of any treatments that might have been administered.

Design

Under the first process four program modules will address specific issues within the FMSS. These modules will be Diagnosis, Epidemiology, Outbreak Investigation, and Surveillance.

Patient Input and Correlation

File Run

Correlation Options

- ☐ With the patients in a data file **Correlate**
- ☐ With the most recently clustered output file
- ☒ With known diseases for a country

Country: **01 ALGERIA**

Patient Name: **Paul Smith**

ID Number: **123456789** **Date:** **031995**

Enter patient symptoms:

Help **Exit**

Correlation values

0.5714	#022	SANDFLY FEVER
0.1690	#029	VIRAL HEPATITIS C
0.1543	#003	CAMPYLOBACTER
0.1543	#017	MALARIA
0.1543	#027	VIRAL HEPATITIS A
0.1543	#031	VIRAL HEPATITIS E
0.1429	#018	MENINGOCOCCAL ME
0.1429	#028	VIRAL HEPATITIS B
0.1429	#030	VIRAL HEPATITIS D

Symptoms selected

016	CHILLS
021	COUGH
031	ENLARGED LYMPH
054	NAUSEA
055	PAIN IN BACK
056	PAIN IN LIMBS
069	RETRO-ORBITAL P

Correlation of patient - Top ten correlations

Correlation	#22	#29	#3	#17	#27	#31	#18	#28	#30	#12
Bar Chart	High	Low	Low	Low	Low	Low	Low	Low	Low	Low

Symptoms List:

- 001 ABDOMINAL PAIN
- 002 ACIDOSIS
- 003 ALBUMINURIA
- 004 ANEMIA
- 005 ANOREXIA
- 006 ARTHRALGIA
- 007 BLOATING
- 008 BLOODY DIARRHEA
- 009 BODY ACHING
- 010 BODY WASTING
- 011 BRADYCARDIA
- 012 BRONCHIOLITIS
- 013 BRONCHITIS
- 014 BURNING ON URINATION
- 015 CERVICITIS
- 017 CIRCULATORY COLLAPSE
- 018 CNS SIGNS
- 019 CONJUNCTIVAL INJECTION
- 020 CONJUNCTIVITIS
- 022 DEHYDRATION
- 023 DELIRIUM
- 024 DIARRHEA

List Symptoms **Summary** **Add Patient** **Exporting**

Figure 4. Prototype screen for Diagnosis Module within FMSS.

Diagnosis Module - Examples of two prototype screens for the Diagnosis Module are shown in Figures 4 and 5. The medical corpsman or attending physician will enter the patient's name and SSN, then choose the appropriate country from a pull-down menu. By clicking on the list of countries' diseases, a list of all infectious and parasitic diseases for that country are shown in the window under Diseases for country chosen. As soon as the country is selected, a list of signs and symptoms for those diseases will appear under the title "Enter the patient symptoms." From this list, the user will select the signs and symptoms of the patient by clicking on any of the ones listed. The user can then click on the Show symptoms button and those symptoms selected will appear in the "Symptoms selected" box. To remove any of the selected symptoms, the user can double click and the system will return to the original list. After all the symptoms are entered, the user will press the button, which then correlates the chosen signs and symptoms with the list of endemic diseases. A bar graph will be displayed showing the relative probabilities of the first 10 diseases along with their names in the box above. In this example, the selected country was Algeria, the presenting symptoms were CHILLS, COUGH, ENLARGED LYMPH NODES, NAUSEA, PAIN IN BACK, PAIN IN LIMBS and RETRO-ORBITAL PAIN. The program determined the most probable disease was SANDFLY FEVER, given that combination of symptoms, with a relative probability of 0.5714, followed by VIRAL HEPATITIS C, with a probability 0.1690.

User input will be processed in the final version using Bayesian inference, which will not only use the signs and symptoms, but also will use ancillary information dynamically linked to data contained in the Epidemiology Module. These data may include incubation period, vector, and reservoir. In addition, a screen to input any laboratory results will be made available. Figure 5 shows an example of the Forecast screen for clusters. This screen displays the curve fit and the measure of the quality of the curve fit from the four fitting options (linear, exponential, self-limiting, and polynomial), plus the graphic and numeric 5-day forecast with one or two standard deviations along with the corresponding probabilities.

Epidemiology Module - The Epidemiology Module will be linked to the Diagnosis Module and will provide the user with additional information for a particular disease. It will follow the format found in the handbook, "Control of Communicable Diseases in Man", which the Navy has adopted and called NAVMED P-5038.¹³ It includes the following information on each disease, if available: (1) IDENTIFICATION, (2) INFECTIOUS AGENT, (3) OCCURRENCE, (4) RESERVOIR, (5) MODE OF TRANSMISSION, (6) INCUBATION PERIOD, (7) PERIOD OF COMMUNICABILITY, (8) SUSCEPTIBILITY AND RESISTANCE, and (9) METHODS OF

CONTROL. This information will be linked to the diseases that appear in the list of differential diagnosis, and well as from the Diseases for country chosen list. When any disease is selected a screen will appear similar to that shown in Figure 6, and it will display all available information for that particular disease. Treatments for each disease will be listed under METHODS OF CONTROL, and will include current treatments as well as recommendations on any preventive measures that should be taken.

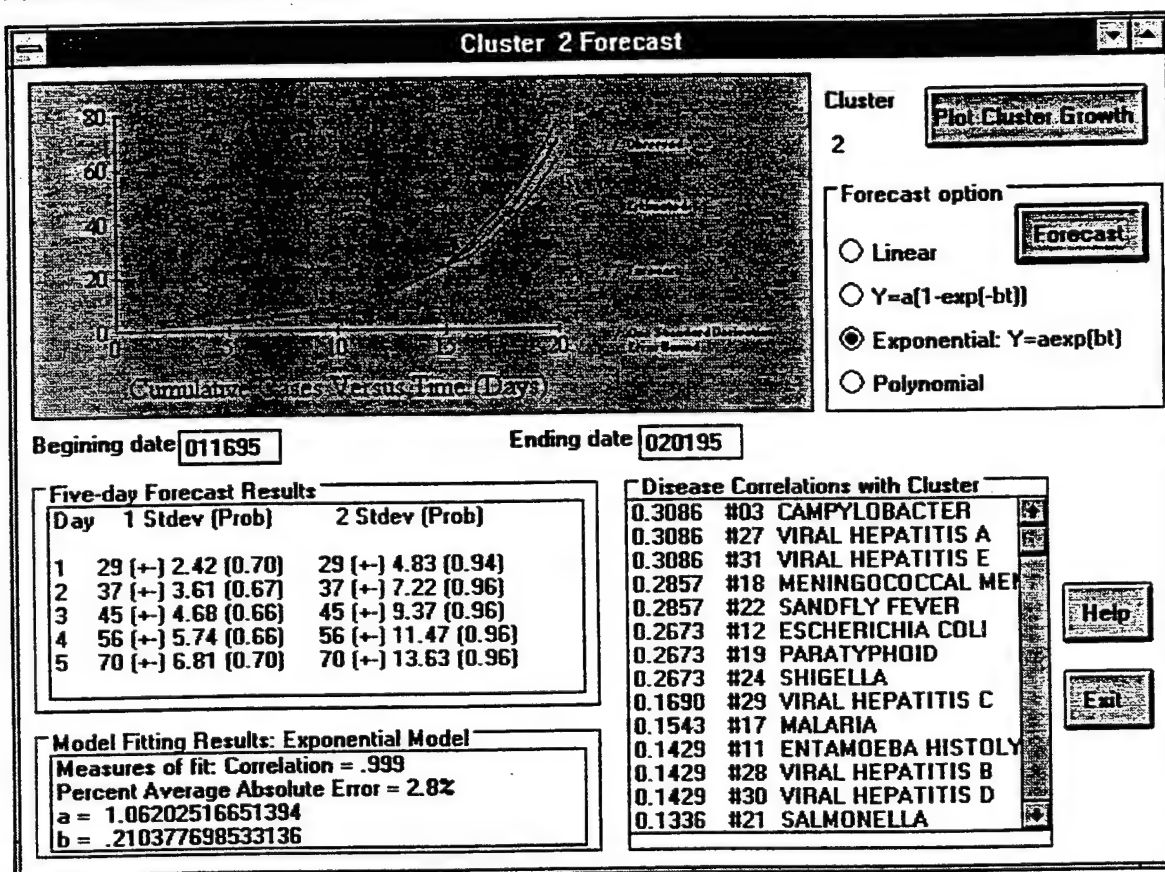


Figure 5. Prototype screen for forecast within FMSS.

Outbreak Investigation Module - This module will provide the user with a binary decision tree for investigating a disease outbreak. Frequently, a very systematic procedure has been developed for investigating the outbreak of a particular disease, and having on-line guidance will help ensure that each step is performed correctly. The user will respond to a set of defined questions with either a Yes or No, and each response will determine the next decision to be made. Having received a report or diagnosis of a suspected case of illness, the user will determine whether the condition is reportable. If the answer is No, then the task is completed. If the answer is Yes, the user will be asked to record and log additional information. After this task is complete

the user will then be prompted to answer another set of questions until the investigation has been completed. The Outbreak Investigation Module will consist of approximately 40 individual binary decision branches. It will be modeled after that used by the Centers for Disease Control and the World Health Organization.¹⁴

CAMPYLOBACTERIOSIS	ICD-9 027.9
DIARRHEA CAUSED BY	ICD-9 008.49
CAMPYLOBACTER	
(Campylobacter enteritis, Vibrionic enteritis)	
<p>1.) Identification- An acute enteric bacterial disease of variable severity characterized by diarrhea, abdominal pain, malaise, fever, nausea and vomiting. The illness is frequently over within 2 to 5 days and usually lasts no more than 10 days. Prolonged illness may occur in adults; relapses can occur. Gross or occult blood in association with mucus and WBCs is often present in the liquid stools. A typhoid-like syndrome, reactive arthritis, and rarely, febrile convulsions and meningitis may occur. Some cases mimic acute appendicitis. Many infections are asymptomatic.</p> <p>Diagnosis is based on isolation of the organisms from stool using selective media, reduced oxygen tension, and an incubation temperature</p>	

Figure 6. Example screen for Epidemiology Module.

Surveillance Module - The Surveillance Module, like the Diagnosis Module, is crucial to the operation of the FMSS. Results obtained from the Diagnosis Module will be dynamically linked to the Surveillance Module, summarized, and plotted. The primary function of this module will be to process incoming data to detect disease trends that may signal an outbreak requiring the attention of preventive medicine personnel. An important component of the Surveillance Module will be the ability to make short-term projections on disease prevalence and noneffectiveness rates (see Fig 5). Having this capability will allow field commanders to better anticipate bed requirements, force strength, and patient regulation and evacuations. Knowing the average duration of an illness, the number of potential individuals at risk, and the rate of increase, one can make short-term projections on the number of lost man-days anticipated, provided no corrective actions are taken. This module also will provide an interactive capability for assessing the effect of potential interventions.

The ability to detect any unusual patterns in the surveillance data collected will rely on various statistical methods. One approach being investigated is collectively termed Statistical Quality Control. These techniques have been developed primarily for use in manufacturing, but they are increasingly finding their way into the medical field.¹⁶ Another statistical method

commonly used with surveillance data is called the scan statistic. This method has been developed to answer the following type of questions: Is the number of cases for a particular disease reported for a certain time period excessive? The scan statistic is the maximum number of reported cases or events in an interval of predetermined length over the time frame of interest. It is used to test the degree of temporal clustering in a data set.¹⁷

CONCLUSIONS

Currently, systems are being designed and developed to capture and process medical data at the forward echelons of medical care. The data gathered can be processed to yield benefit to the practice of preventive medicine under combat conditions. To realize this benefit, however, methods for detecting medical problems need to be incorporated into these outpatient systems. Having the capability of using routinely collected data to assess the magnitude of field medical problems while following their progress will enable EHOs and PMOs to focus on areas of emerging health problems. Furthermore, this information will help to determine the amount and type of resources needed to bring a particular problem under control. In addition to having the ability to detect and monitor medical problems as they occur, this information also will provide commanders with the current numbers of noneffective personnel and estimate whether the numbers will potentially increase or decrease. With the development of portable computers and advanced communications, these methods can now be used in an operational theater.

References

1. Gordon JE. General considerations of modes of transmission. In: Hoff EC, ed. *Preventive Medicine in World War II. Communicable Diseases*. Washington, DC: Office of the Surgeon General, U.S. Department of the Army; 1958; 4:8-38.
2. Hyams KC, Bourgeois AL, Merrell BR, Rozmajzl P, Escamilla J, Thornton SA, Wasserman GM, Burke A, Echeverria PE, Green KY, Kapikian AZ, Woody JN. Diarrheal disease during Operation Desert Shield. *N Engl J Med* . 1991;325: 1423-1428.
3. DeMaio J, Bailey L. A major outbreak of foodborne gastroenteritis among Air Force personnel during Operation Desert Storm. *Milit Med* 1993;158:161-164.
4. Oldfield ED, Wallace MR, Hyams KC, Yousif AA, Lewis DE, Bourgeois LA. Endemic infections diseases of the Middle East. *Rev Infect Dis* 1991;13(Suppl 3):S199-S217
5. Preventive Medicine Services Section I. *The Medical Threat. In Planning For Health Service Support*. FM 8-55 Headquarters, Department of the Army; 1984.
6. Oldfield ED, Guenael RR, Gray GC. The endemic diseases of Somalia. *Rev Infect Dis* 1993;16(Suppl 3):S132-S157.
7. Sharp TW, Thornton SA, Wallace MR, Defraites RF, Sanchez JL, Batchelor RA, Rozmajzl PJ, Hanson K, Echeverria P, Kapikian AZ, Xiang XJ, Estes MK, Burans JP. Diarrheal Disease Among Military Personnel During Operation Restore Hope, Somalia, 1992-1993. *Am J Trop Med Hyg* 1995; 52(2):188-193.
8. Disease and Environmental Alert Reports (DEAR), *Armed Forces Medical Intelligence Center*, Fort Detrick, Frederick, MD., 1994.
9. Berger SA, Blackman U. Computer program for diagnosing and teaching geographic medicine. *J Travel Med* 1995; 2:199-203
10. Centers for Disease Control and Prevention. *Addressing emerging infectious threats: A prevention strategy for the United States*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, 1994.
11. Berger SA, Blackman U. A computer-driven Bayesian matrix for the diagnosis of infectious diseases. Department of Microbiology, Ichilov Hospital, 6 Weitzman Street, Tel-Aviv 64239, Israel, 1994.
12. Angus, JE. Dynamic aggregation of symptom data. *Naval Health Research Center, 1996. Technical Report # 95-34*.
13. Benenson, AS (Ed.), Control of communicable diseases in man. 5th Ed. Washington, DC: American Public Health Association, 1990.

14. Public Health Service, Centers for Disease Control. Introduction to Applied Epidemiology. U.S. Department of Health and Human Services, Atlanta, Georgia, 1980.
15. Laffel G, Blumenthal D. The case for using industrial quality management science in health care organizations. *JAMA*. 1989;262(20):2869-2873.
16. Teutsch SM, Churchill RE. (Ed.) Principles and Practice of Public Health Surveillance. New York: Oxford University Press 1994.

Appendix

Table 1. Diseases and pathogens included in the data base.

Abscess, intraabdominal	Dracunculiasis	Lobomycosis
Actinomycosis	Eastern equine encephalitis	Loiasis
Adenovirus infection	Ebola Disease	Louping ill
Aeromonas & marine Vibrio infx.	Echinococcosis	Lyme disease
AIDS	Echinococcus - multilocular	Lymphocytic choriomeningitis
Amebiasis	Echinococcus vogeli infection	Lymphogranuloma venereum
Amoeba - free living	Echinostomiasis	Malaria
Angiostrongyliasis	Ehrlichiosis - E. chaffeensis	Malignant otitis externa
Angiostrongyliasis abdominal	Ehrlichiosis - E. sennetsu	Mansonelliasis - M. ozzardi
Anisakiasis	Endemic syphilis (bejel)	Mansonelliasis - M. perstans
Anthrax	Endocarditis - infectious	Mansonelliasis - M. streptocerca
Argentine hemorrhagic fever	Entamoeba polecki infection	Marburg virus disease
Ascariasis	Enteritis necroticans	Mayaro
Aseptic meningitis, viral	Enterobiasis	Measles
Aspergillosis	Enterovirus infection	Mediterranean spotted fever
Babesiosis	Entomophthoromycosis	Melioidosis
Bacillary angiomatosis	Epidural abscess	Meningitis, bacterial
Bacillus cereus food poisoning	Erysipelas or cellulitis	Metagonimiasis
Balantidiasis	Erysipeloid	Microsporidiosis
Bartonellosis	Erythrasma	Monkeypox
Bertielliasis	Escherichia coli diarrhea	Mononucleosis, infectious
Blastocystis hominis infection	European tick encephalitis	Mucocutaneous leishmaniasis
Blastomycosis	Far eastern tick-borne enceph.	Mumps
Bolivian hemorrhagic fever	Fascioliasis	Murray Valley encephalitis
Botulism	Fasciolopsiasis	Mycetoma
Brain abscess	Filariasis - Brugia malayi	Mycobacteriosis - M. marinum
Brazilian purpuric fever	Filariasis - Brugia timori	Mycobacteriosis - M. scrofulaceum
Brucellosis	Filariasis - Bancroftian	Mycobacteriosis - M. ulcerans
California encephalitis group	Gardnerella vaginalis infection	Mycobacteriosis - systemic
Campylobacteriosis	Gastrodiscoidiasis	Mycoplasma pneumoniae infection
Candidiasis	Giardiasis	Myiasis
Capillariasis, hepatic	Glanders	Nanophyetiasis
Capillariasis, intestinal	Gnathostomiasis	Necrotizing skin/soft tissue infx.
Cat scratch disease	Gonorrhea	Nocardiosis
Cercarial dermatitis	Granuloma inguinale	North Asian tick typhus
Chancroid	Group C viral fevers	Norwalk agent gastroenteritis
Chikungunya	Hantavirus resp. distress syndrome	O'nyong nyong
Chlamydia infections, misc.	Hemorrhagic fever & renal syndrome	Ockelbo disease
Chlamydia pneumoniae infection	Hepatitis A	Oesophagostomiasis
Cholecystitis & cholangitis	Hepatitis B	Omsk hemorrhagic fever
Cholera	Hepatitis C	Onchocerciasis
Chromomycosis	Hepatitis delta infection	Opisthorchiasis
Chronic fatigue syndrome	Hepatitis, non-A non-B (enteric)	Orbital infection
Chronic meningococcemia	Herpes simplex infection	Orf
Clonorchiasis	Herpes simplex encephalitis	Ornithosis
Clostridial food poisoning	Herpesvirus simiae infection	Oropouche
Clostridial myonecrosis	Herpes zoster	Osteomyelitis
Clostridium difficile colitis	Heterophyiasis	Otitis media
Coccidioidomycosis	Histoplasmosis	Paracoccidioidomycosis
Coenurosis	Histoplasmosis - African	Paragonimiasis
Colorado tick fever	HIV infection - initial illness	Parainfluenza virus infection
Common cold	Hookworm	Parvovirus B19 infection
Conjunctivitis inclusion	Hymenolepis diminuta infection	Pasteurellosis
Conjunctivitis viral	Hymenolepis nana infection	Pediculosis
Cowpox	Ilheus	Penicilliosis
Crimean Congo hemorrhagic fever	Influenza	Pentastomiasis
Cryptococcosis	Intracranial venous thrombosis	Pericarditis, bacterial
Cryptosporidiosis	Isosporiasis	Perinephric abscess
Cutaneous larva migrans	Japanese encephalitis	Perirectal abscess
Cutaneous leishmaniasis	Karelian fever	Peritonitis, bacterial
Cyclospora infection	Kawasaki disease	Pertussis
Cysticercosis	Kingella infection	Pharyngeal & cervical space infx.
Cytomegalovirus infection	Kyasanur Forest disease	Pharyngitis, acute bacterial
Dengue	Lagochilascariasis	Pinta
Dermatophytosis	Laryngotracheobronchitis	Plague
Dicrocoeliasis	Lassa fever	Plesiomonas enteritis
Dientamoeba diarrhea	Legionellosis	Pleurodynia
Diectophyme renale infection	Leprosy	Pneumocystis pneumonia
Diphtheria	Leptospirosis	Pneumonia, bacterial
Diphyllobothriasis	Linguatulosi	Pogosta disease
Dipylidiasis	Listeriosis	Poliomyelitis (wild or vaccine)
Dirofilariasis	Liver abscess, bacterial	Powassan

Pseudocowpox
 Pyoderma (impetigo, abscess, etc)
 Pyomyositis
 Q fever
 Queensland tick typhus
 Rabies
 Rat bite fever - spirillary
 Rat bite fever - streptobacillary
 Relapsing fever
 Respiratory syncytial infection
 Reye's syndrome
 Rheumatic fever
 Rhinoscleroma
 Rhinoporioidosis
 Rhodococcus equi infection
 Rickettsialpox
 Rift Valley fever
 Rocio
 Rocky Mountain spotted fever
 Roseola or human herpesvirus 6
 Ross River disease
 Rotavirus infection
 Rubella
 Sabia
 Salmonellosis
 Sandfly fever
 Sarcocystosis
 Scabies
 Scarlet fever
 Schistosomiasis - haematobium
 Schistosomiasis - intercalatum

Schistosomiasis - japonicum
 Schistosomiasis - mansoni
 Schistosomiasis - matthei
 Schistosomiasis - mekongi
 Septicemia, bacterial
 Septicemia, fungal
 Shigellosis
 Sindbis
 Sinusitis
 Smallpox
 Sparganosis
 Spondweni
 Sporotrichosis
 St. Louis encephalitis
 Staphylococcal food poisoning
 Strongyloidiasis
 Subdural empyema
 Suppurative parotitis
 Syngamiasis
 Syphilis
 Taeniasis
 Tanapox virus disease
 Tetanus
 Thelaziasis
 Thogoto
 Toxic shock syndrome
 Toxocariasis
 Toxoplasmosis
 Trachoma
 Trench fever
 Trichinosis

Trichomoniasis
 Trichostrongyliasis
 Trichuriasis
 Tropical phagedenic ulcer
 Tropical pulmonary eosinophilia
 Trypanosomiasis - African
 Trypanosomiasis - American
 Tuberculosis
 Tularemia
 Tungiasis
 Typhoid and enteric fever
 Typhus - endemic
 Typhus - epidemic
 Typhus - scrub
 Urinary tract infection
 Varicella
 Venezuelan equine encephalitis
 Venezuelan hemorrhagic fever
 Vesicular stomatitis disease
 Vibrio parahaemolyticus infection
 Visceral leishmaniasis
 Wesselbron
 West Nile Fever
 Western equine encephalitis
 Whipple's disease
 Wound infection
 Yaws
 Yellow fever
 Yersiniosis
 Zygomycosis

Table 2: Evaluation of a computer-driven infectious disease diagnosis program (percent)

Nature of infection

	bacterial	parasitic	viral	fungal	total	correct *
actual cases	150	30	100	15	295	222 (75.3)
hypothetical cases	97	60	33	10	200	128 (64.0)
total	247	90	133	25	495	
correct diagnosis *	186 (75.3)	60 (66.7)	88 (66.2)	16 (64.0)	350 (70.7)	
diagnosis included in differential **	236 (95.5)	87 (96.7)	124 (93.2)	22 (88.0)	469 (94.7)	

Country of acquisition

	Israel	Africa	Southeast Asia	Europe	Latin America	North America	Other
Number of cases	308	66	65	24	7	19	6
correct diagnosis *	205 (66.6)	54 (81.8)	54 (83.1)	16 (66.7)	5 (71.4)	12 (63.2)	4 (66.7)
diagnosis included in differential **	295 (95.8)	62 (93.9)	61 (93.8)	23 (95.8)	6 (85.7)	18 (94.7)	4 (66.7)

* concordance between correct clinical diagnosis and disease ranked first in the differential diagnosis list

** the correct clinical diagnosis is included in the computer-generated diagnosis list

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